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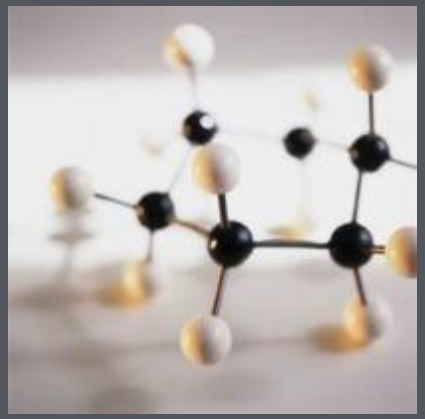

FY 2013 Bioenergy Technologies Office Overview to Technical Advisory Committee

Valerie Sarisky-Reed, Ph.D
Acting Program Director
Bioenergy Technologies Office

Bioenergy Technologies Office Overview (BETO)

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Mission: Through targeted RDD&D, enable sustainable, nationwide production of advanced biofuels that that will displace a share of petroleum-derived fuels, mitigate climate change, create American jobs, and increase U.S. energy security.

Research, Development, Demonstration, & Deployment

Feedstock Supply

Develop sustainable, secure, reliable, and affordable biomass feedstock supply.

Conversion R&D

Develop commercially viable technologies for converting biomass feedstocks into fungible, liquid transportation fuels, bioproducts and chemical intermediates

Demonstration & Deployment

Demonstrate and validate integrated technologies with successful construction and operation of cost-shared pilot, demonstration, and commercial scale facilities

Cross Cutting

Sustainability

Promote the positive economic, social, and environmental effects, while reducing potential negative impacts of biofuels

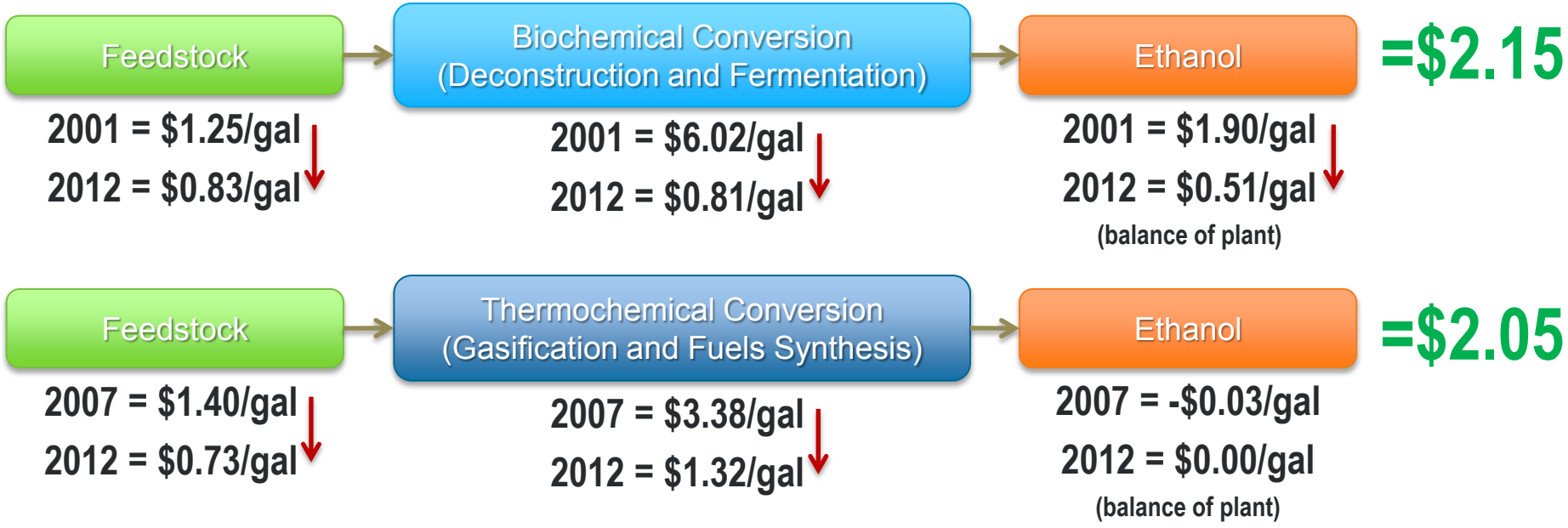
Strategic Analysis

Provide context for decisions by establishing quantitative metrics, tracking progress toward goals, and informing portfolio planning and management

Cellulosic Ethanol Accomplishments

In September 2012, scientists at DOE's National Laboratories successfully valdiated through a pilot scale demonstration, feedstock and conversion processes that reduced the cost of production of cellulosic ethanol.

- ~90% reduction in enzyme cost through development of new enzymes for biochemical processing ($3.45/gal to $0.36/gal)
- New microbes that can use more sugars (glucose, xylose, arabinose) - from ~50% to >95%
- Improved methane conversion in thermochemical processes - from 20% to 80%



Benefits to the biofuels industry:

- ✓ **Enables meeting the Renewable Fuel Standard production target of 16 billion gallons of cellulosic biofuel by 2022**
- ✓ **Breakthroughs can be leveraged to advance cellulosic biomass to hydrocarbon biofuels or bioproducts**
  - ► Reduce usage of petroleum for gasoline, diesel, jet, and products
- ✓ **Enables development of a United States bioeconomy**
  - ► Utilizes unique United States biomass capacity
  - ► Greater energy security
  - ► Reduced dependence on foreign oil
  - ► Cuts costs at the pump
  - ► New American jobs

IBR Project Status Highlights

- BETO has awarded 29 cooperative agreements covering a diverse set of technologies and feedstocks including 4 commercial scale, 11 demonstration scale, 12 pilot scale and 2 R&D design projects.
  - 21 are active. Those include 12 biochemical technologies, 6 thermochemical and 3 algal technologies.
  - 13 projects are focused on cellulosic ethanol and 8 projects are focused on renewable hydrocarbons.
  - 3 have been completed.
  - 5 were terminated for lack of technical progress or lack of cost share.
- Expected March 2013, 1 Pre-commercial scale biorefinery will be coming online to start producing 8 mmgy cellulosic ethanol; the first DOE-supported operating cellulosic ethanol production facility in the US.
- 2 Commercial-scale biorefineries are currently under construction and due for completion in 2014; two more projects are scheduled for completion in 2015, bringing the DOE-sponsored production capacity to 80 mmgy by 2015.

Integrated Biorefinery Locations

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Grey markers signify projects that are no longer active with the Bioenergy Technologies Office

http://www.eere.energy.gov/biomass/integrated_biorefineries.html

BETO Funding

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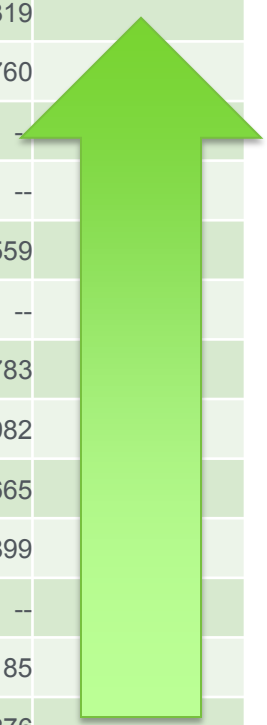
	FY 2012 Current	FY 2013 Request	FY 2013 House	FY 2013 Senate	FY 2013 CR	FY 2014 Request
Feedstock Infrastructure	5,971	16,592	24,250	16,490	16,430	
Algae Feedstock	29,067	29,280	14,550	29,400	28,995	
Conversion Total	102,418	112,767	80,510	77,600	77,319	
Biochemical	50,733	56,870	40,255	35,890	35,760	
Carbon Fiber Initiative	--	--	--	--	--	
Waste-to-Energy	--	--	--	--	--	
Thermochemical	51,685	55,897	40,255	41,710	41,559	
BRDI Joint Solicitation/Incubator Program	--	--	--	--	--	
Integrated Biorefineries	42,897	94,000	70,000	60,000	59,783	
DPA	--	40,000	--	5,000	4,982	
Analysis/Sustainability	9,813	9,695	9,700	9,700	9,665	
Biopower/Cookstoves	4,829	2,909	--	2,910	2,899	
NREL Lab Facilities	--	--	--	--	--	
SBIR/STTR	4,281	4,757	3,990	3,900	4,185	
Total, Bioenergy Technologies	199,276	270,000	203,000	200,000	199,276	



***In thousands of dollars**

FY 14 Proposed Activities

Goal: Reduce the cost of biofuels to be competitive with petroleum-based fuels in the market. BETO will continue core R&D to reduce the cost of advanced biofuels.

New FY14 FOAs

- Sugars FOA: Biomass to Lignocellulosic Sugars to Hydrocarbons
- Syngas FOA: Syngas to Hydrocarbon Fuels and Fuel Components
- DPA Potential FOA: DPA MOU Drop-in Fuels

Additional Selections from FY13 FOAs

- Algae FOA: Enhanced Biological Yield
- Feedstock Logistics FOA

FY14 New Priority Area:

- Waste-to-Energy: The Program plans to expand its focus to include the organic fraction of municipal solid waste and bio-solids, with initial efforts targeting improvements in anaerobic digestion.
- Incubator Program for small business/industry to develop innovative concepts and link to the capital already invested in by the DOE

Innovative Pilot FOA

- DOE issued a funding opportunity announcement of $20M (with 50/50 cost share requirement) for innovative pilot and demonstration scale facilities using FY12 appropriated funds.
- The solicitation was released to enable the production of hydrocarbon blendstocks at pilot or demonstration scales – JP-5 (jet fuel primarily for the Navy), JP-8 (jet fuel primarily for the Air Force), or F-76 (diesel). Two topic areas will be supported:
  - Topic Area 1: Applicants were requested to design, construct, and/or operate an integrated biorefinery in order to validate the proposed technology using an acceptable lignocellulosic or waste-based feedstock to create an acceptable biofuel.
  - Topic Area 2: Applicants were requested to design, construct, and/or operate an integrated biorefinery in order to validate the proposed technology using an acceptable algal-type feedstock to produce an acceptable biofuel.
- Proposals were due on September 13, 2012. The merit review process has been completed and announcements are anticipated in March 2013.

Advanced Biofuels Initiative/DPA

DOE, USDA & Navy: MOU signed July 2011 by Secretary Chu, Vilsack, and Mabus to support sustainable, commercial-scale biorefineries to produce hydrocarbon jet and diesel biofuels in the near-term. The Defense Production Act (DPA) Initiative would require funding of $510 million with a 50/50 (government/industry) cost share requirement. The DOE commitment is $170 million to be provided over three years.

DPA FOA

- A funding opportunity announcement was released on June 27, 2012 for the production of hydrocarbon fuels at pilot or demonstration scale facilities that meet military blend fuel specifications. Two topic areas will be supported:
  - Technologies that utilize algae (micro, macro, cyanobacteria, heterotrophic)
  - Technologies that utilize lignocellulosic biomass and other waste feedstocks
- Proposals were due on August 13, 2012. The proposal merit review process has been completed and involved technical experts from DOE, Navy, and USDA.
- In coordination with Navy, USDA, and the White House, a public announcement is anticipated for mid-March 2013.

Aviation Biofuels

- The Bioenergy Technologies Office is advancing research being done for renewable aviation fuels, including techno-economic modeling, feedstock logistics solutions, fuel processing pathways, and greenhouse gas lifecycle assessments.

- With 25 pilot and demonstration scale facilities across the country, BETO is now focusing on eight additional pathways that can produce jet fuel including:
  - Three thermochemical (pyrolysis) technical approaches
  - Biochemical conversion processes including both biological conversion and catalytic upgrading of sugars to hydrocarbons
  - Two algae-based pathways
  - Gasification followed by upgrading of synthesis gas to hydrocarbon fuels.

- The initial analysis of these pathways will be conducted over the next two to three years.

Aviation Biofuels

- BETO is committed to strengthening the relationship between the DOE and the aviation sector in order to help advance the renewable jet fuel industry. With increased activities with the military, airline industry, and government partners including the Federal Aviation Administration (FAA), BETO has supported applied research to develop, scale up and commercialize advanced aviation biofuel technologies.

- As part of the increased collaboration with the aviation industry, BETO, along with the Commercial Aviation Alternative Fuels Initiative (CAAFI) and the FAA, held a meeting in November 2012 focused on all parts of the supply chain of aviation biofuels.

  – This workshop focused specifically on the cost of production for renewable jet fuels, and brought together DOE technologists and techno-economic modeling experts, jet fuel customers (commercial and military), aerospace research professionals, and technical experts to examine the issues involved across the whole supply chain.

Bioproducts

Only about 44% of a barrel of crude oil is used to produce light duty petroleum gasoline. About 25% is used to produce petroleum diesel fuel, and about **17% is used to produce petroleum products.**

Legislative Driver

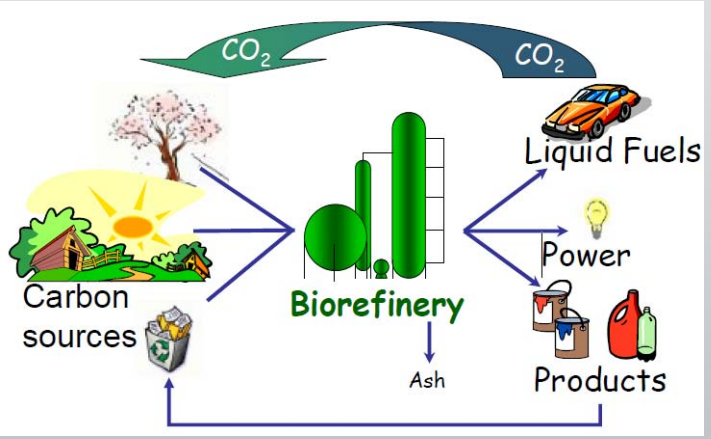
Section 932 of Energy Policy Act (EPAct) / 2005

"The Secretary shall conduct a program of research, development, demonstration, and commercial application for bioenergy, including …
(3) **bioproducts**; (4) integrated biorefineries that may produce biopower, biofuels, and **bioproducts**..."

Other Drivers

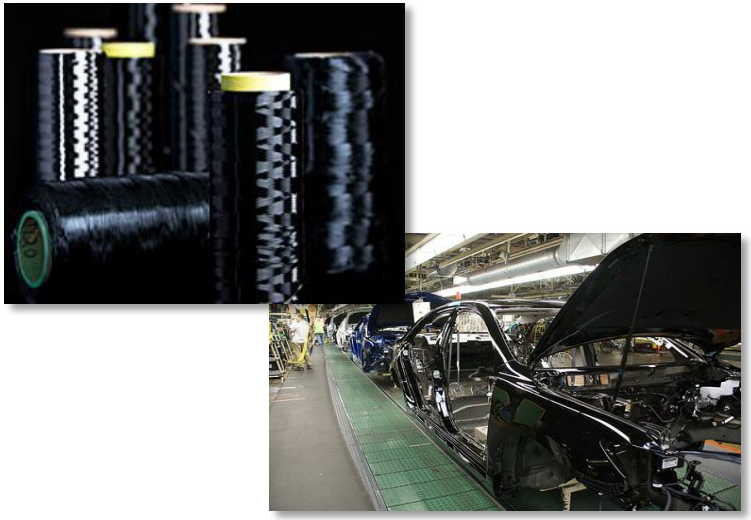
- Leverage biofuels R&D on cellulosic biomass
- Return to "natural order" of technology development
- Replace the whole barrel
- Improve project economics via:
  - More valuable primary or secondary products
  - More "chemically-appropriate" products

For the industry to be as effective as possible, we need to focus on research, development, demonstration, and deployment of a range of technologies to displace the entire barrel of petroleum crude.



Biomass-Derived Carbon Fiber

- Produce carbon fiber (CF) from biomass
- Two Paths for R&D
  - ► Lignin
  - ► Bio-derived PAN precursor
- Enable lower cost precursors and lessen dependence on oil



EERE Partnerships

Innovations in Biomass Fractionation	Innovations in Renewable Chemical Manufacturing	Innovations in CF Manufacturing	Innovations in Automotive Lightweighting
BETO		AMO	VTO

Value Proposition

$0.10/lb cellulosic sugars & lignin that meets spec for biorefining → **10X** → **$1.00/lb** chemical intermediates that meets spec for CF → **5X** → **$5.00/lb** CF that meets specs for autos and trucks

Incubator Program

- **Intent of Program**
  - Assist small and start-up companies in prototype and pilot-stage process development for next generation technologies. It is expected that technologies awarded in this program will address the barriers/challenges attributed to the feedstock, thermochemical, and biochemical platforms as identified in the BETO Multi-Year Program Plan.
- **Eligibility**
  - Applicants may be limited to small businesses or start-up companies (< 5 years old), or eligibility may be open to all with preference given to these entities.
- **Program Strategy**
  - This framework would provide increased access to BETO's laboratories and PDUs with equipment and personnel that would not otherwise be readily available to the applicants for scale-up testing, thereby addressing a key bottleneck for small, innovative biofuel firms.

Natural Gas

- Recent Developments
  - BETO has received several requests from industry to investigate whether a combination of natural gas and biomass could be utilized to produce liquid transportation fuels and products.
  - Two biofuels companies have announced their intention to abandon biomass as a feedstock and utilize natural gas to produce liquid fuels.
- Workshop (September 2013)
  - BETO, in coordination with the Office of Fossil Energy and NETL, will host a one-day workshop addressing natural gas-biomass-to-liquids (GBTL) research needs and technology options.
  - Objective of this event is to obtain input from industry, academia, research establishments, and other experts on whether or not there is a role for DOE to conduct R&D and develop new process technologies.